

Introduction to NASA Water Products

Rain, Snow, Soil Moisture, Ground Water, Evapotranspiration

NASA Remote Sensing Training
Norman, Oklahoma, June 19-20, 2012

ARSET
Applied Remote Sensing Training

A project of NASA Applied Sciences



Objective

To present an overview of NASA water resource products from **satellites and models**



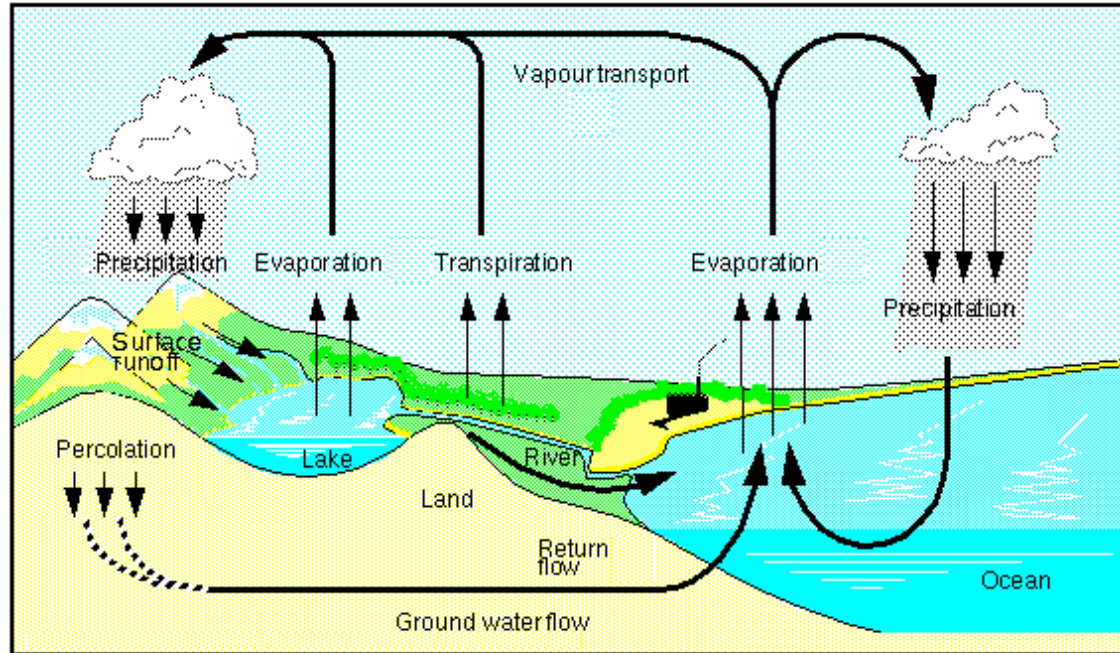
Part 1 :
Overview of
Remote Sensing
and Modeling
Approaches

Part 2 :
Brief Description of
Water Products
from Various
Sources: **Rain,**
Snow, Soil
Moisture, Ground
Water, ET

NASA Applied Sciences Program
Water Resources site: <http://wmp.gsfc.nasa.gov/>

NASA Water Products

- Rain
- Snow/Ice
- Water Vapor
- Clouds
- Soil Moisture
- Ground Water
- Snow/Ice
- Rain, Clouds, Water Vapor
- Soil Moisture
- Evaporation/Transpiration
- Run off



Courtesy Erich Roeckner, Max Planck Institute for Meteorology

Water Cycle Components

Products in red - derived from satellite measurements

Products in blue - derived from atmospheric/land surface models in which satellite measurements are assimilated

NASA Water Products

- **Rain:**

	Units
Rain Rate at surface (amount of rainfall per unit area per unit of time)	mm/hour
Accumulated Rain (rain amount over a day or a month)	mm
Vertical Precipitation Rate profile (liquid and frozen rain rate at various levels in the atmosphere)	mm/hour
- **Snow:**

Snowfall Rate (amount of snowfall per unit area per unit of time)	Kg/m ² /hour
Fractional Snow Cover Area	Fraction
Snow Depth	m
Snow Mass	Kg/m ²
Snow water Equivalent	Kg/m ²
- **Soil Moisture:**

Top Soil Layer Wetness	Fraction
Soil Moisture	Kg/m ²
- **Terrestrial Water:**

Column Equivalent of Water	cm
[ground water+soil moisture +surface water]	
- **Evapotranspiration:**

	Kg/m ²
--	-------------------

NASA Rain Products

Source: Satellite and Surface-based measurements

Global Precipitation Climatology Project (GPCP) – based on multiple, US and global satellites

Tropical Rainfall measuring Mission (TRMM)

Source: Satellite and Surface Data Assimilated Models

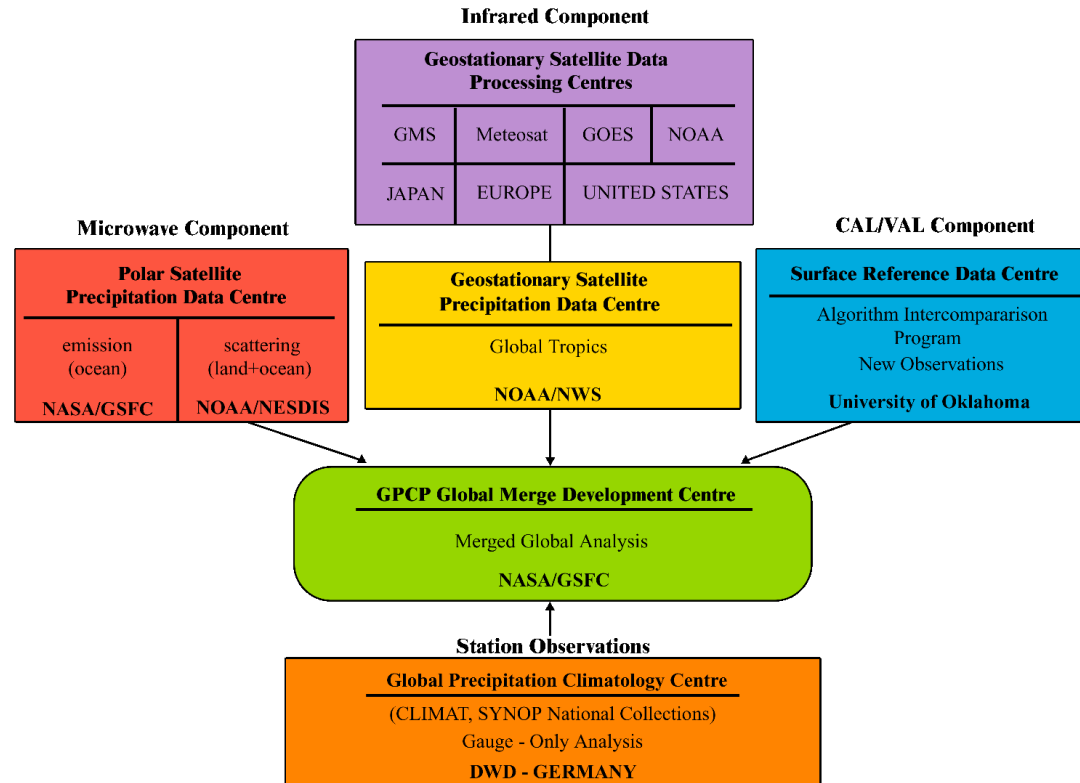
Modern Era Retrospective-Analysis for Research and Applications (MERRA)

NASA Rain Products

GPCP

Data from over 6,000 rain gauge stations, and satellite geostationary and low-orbit infrared, passive microwave, and sounding observations have been merged to estimate monthly rainfall.

Global Precipitation Climatology Project



NASA Rain Products

TRMM

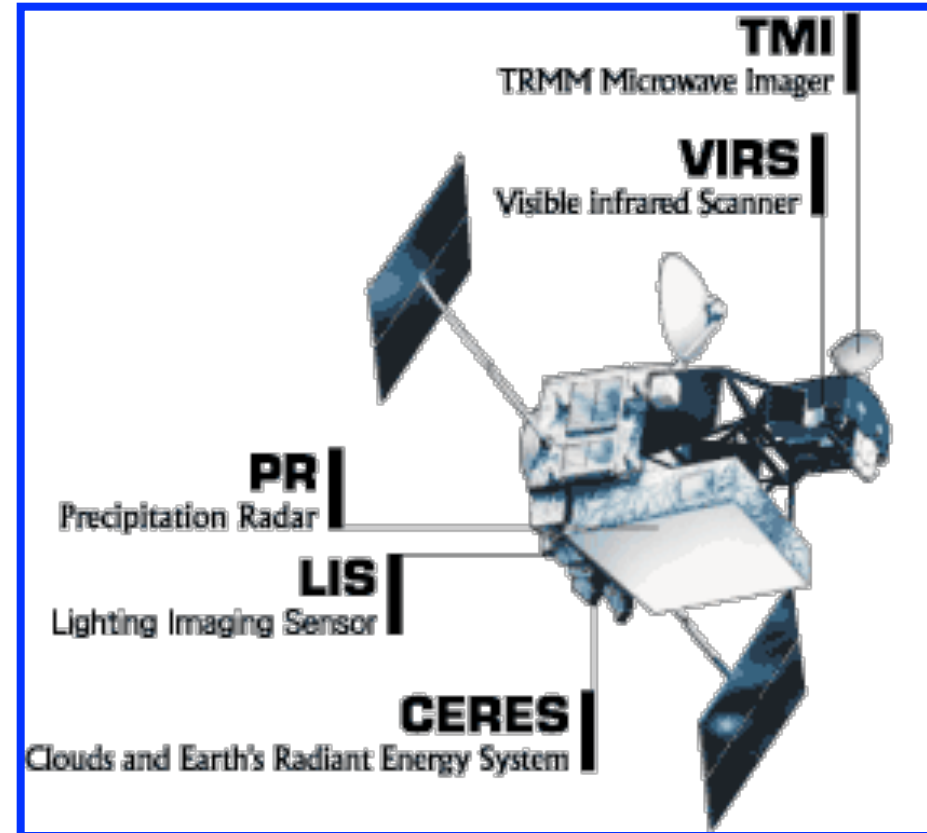
TRMM Instruments: infrared, visible, active and passive microwave

Precipitation Radar (**PR**)
(First rainfall sensing radar in Space)

TRMM Microwave Imager (**TMI**)

Visible and Infrared Scanner (**VIRS**)

TRMM merged product combines measurements from all instruments and other satellites along with rain gauge data



NASA Snow, Soil Moisture, and Evapotranspiration (ET) Products

Source: Satellites

Terra/MODIS -- snow/ice and ET

Aqua/MODIS -- snow/ice, ET

Aqua/AMSR-E – snow/ice, soil moisture

Source: Satellite and Surface Data Assimilated Models

Modern Era Retrospective-Analysis for Research and Applications (MERRA)

Global Land Data Assimilation System (GLDAS)

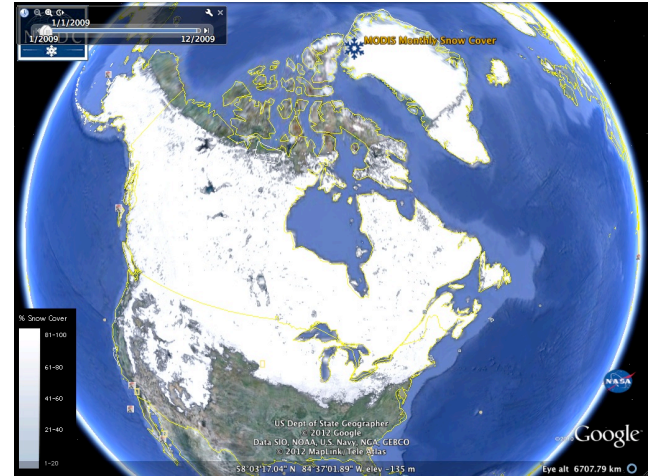
North American Land Data Assimilation System (NLDAS)

NASA Snow, Soil Moisture, and ET Products

Terra and Aqua

Instrument: MODerate Resolution Imaging Spectroradiometer (**MODIS**)

Products: snow, vegetation index (Used in ET calculations)

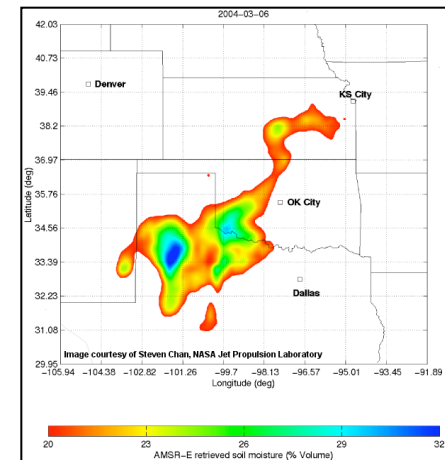


MODIS Snow Cover January 2009

Aqua

Instrument:
Advanced Microwave Scanning Radiometer
for EOS (**AMSR-E**)

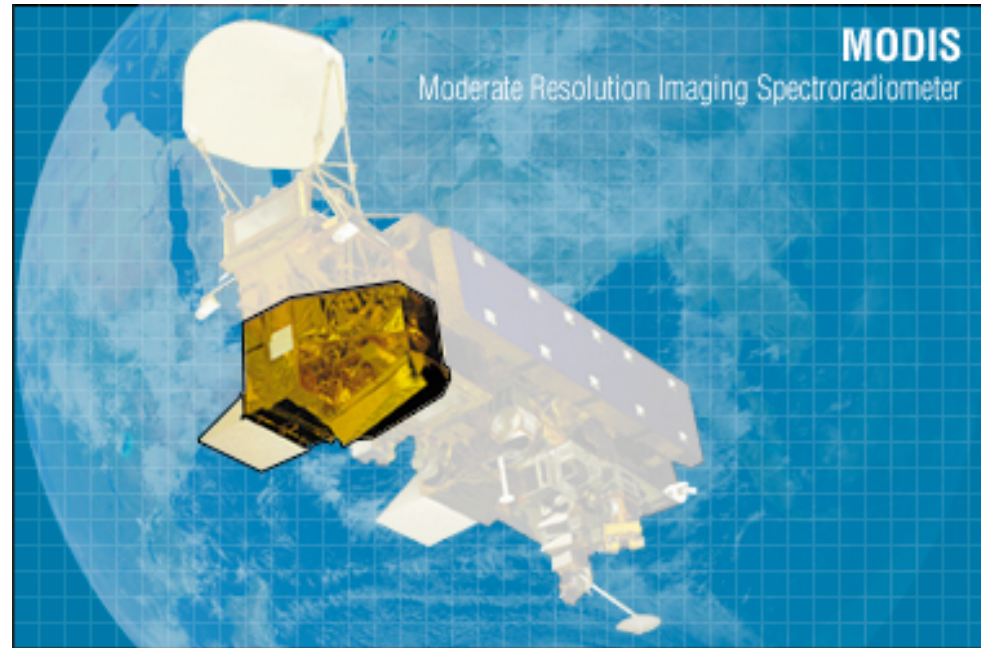
Products: snow water equivalent, soil
moisture



Oklahoma Flood - Soil
Moisture from AMSR-E (03
March 2004)

MODerate Resolution Imaging Spectroradiometer (MODIS)

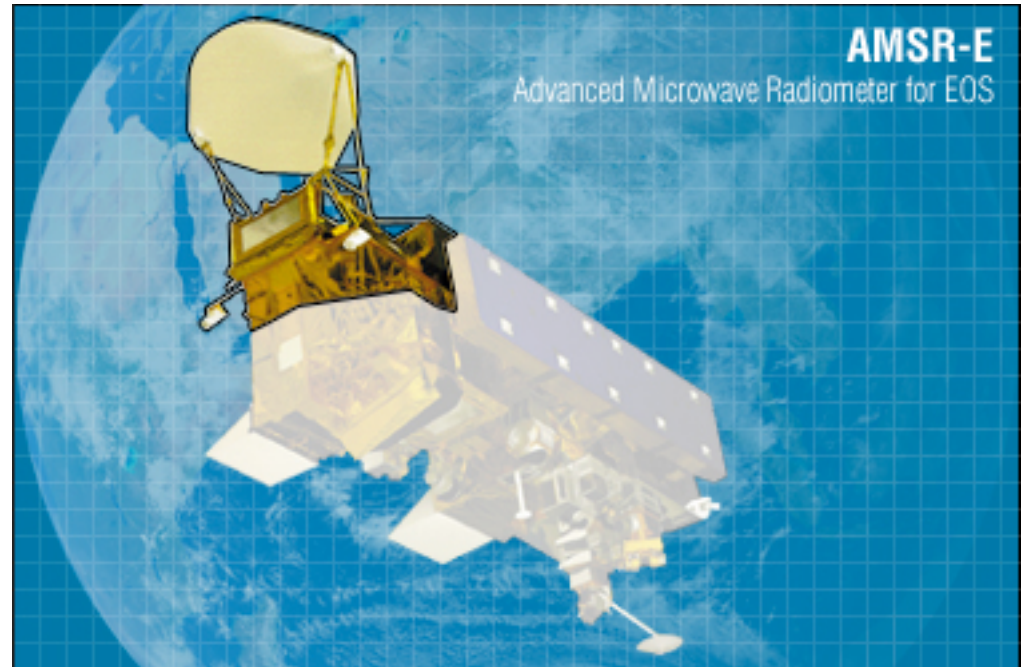
- 36 spectral bands ranging from 0.41 to 14.385 microns
- Many applications, including clouds, snow/ice, vegetation, ET, aerosol
- Available in various resolution (depends on product)



On-board Terra and Aqua satellites

Advanced Microwave Scanning Radiometer for EOS (AMSR-E)

- Provides snow/ice, soil moisture
- Twelve-channel, six-frequency, passive-microwave 6.925, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz



On-board Aqua satellite

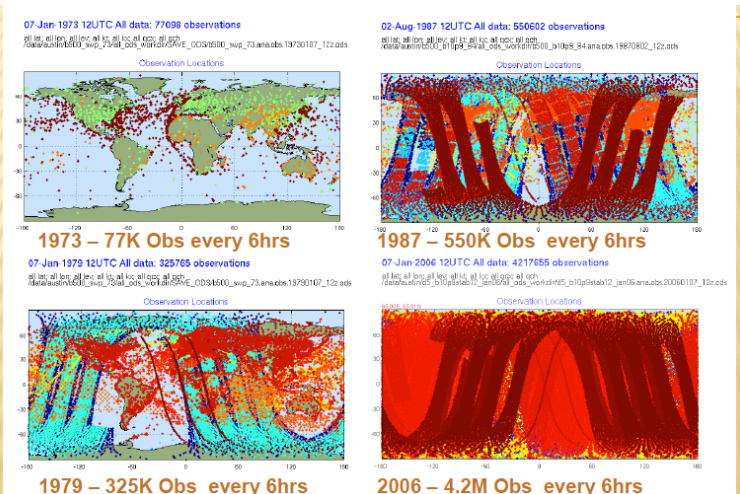
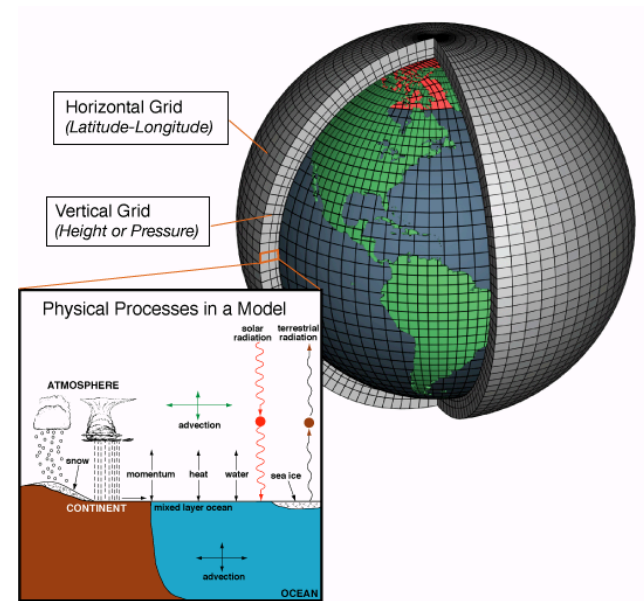
NASA Rain, Snow, Soil Moisture, and ET Products

MERRA

Satellite and surface data are assimilated in NASA atmospheric model.

Rain products are calculated numerically based on physical processes represented in the model

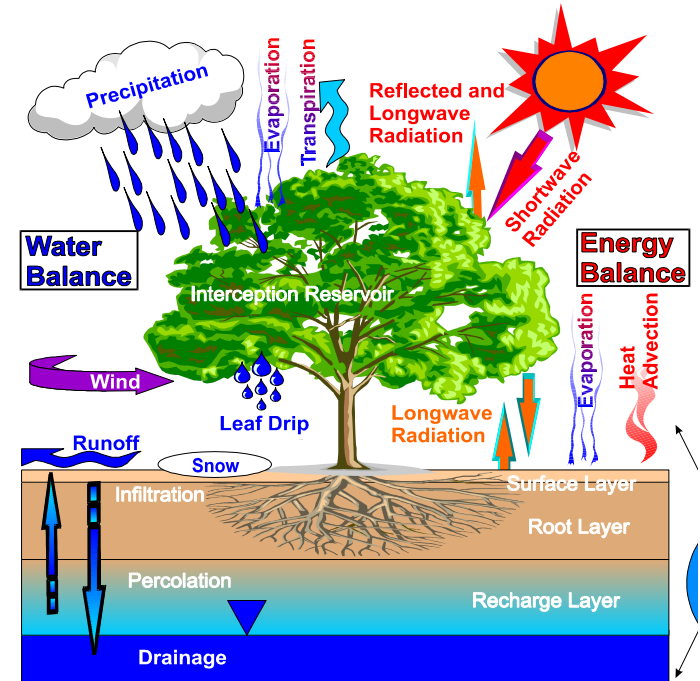
Land Surface Model (LSM)
forced by MERRA atmospheric
analysis is used to get Soil
Moisture, ET, and Snow products



NASA Rain, Snow, Soil Moisture, and ET Products

GLDAS: Global, Satellite and surface-based observations of precipitation and downward radiation products, and analyses from atmospheric data assimilation systems are employed to force Land Surface Models (LSMs). Data assimilation techniques for incorporating satellite based hydrological products, including snow cover and water equivalent, soil moisture, surface temperature, and leaf area index.

NLDAS: Over north America, forcing dataset from high-resolution surface gauge and radar based observed precipitation data, satellite and/or model based surface radiative energy and surface meteorology drive LSMs to produce model outputs of surface fluxes, soil moisture, and snow cover.



LSM - SURFACE VEGETATION-
ATMOSPHERE TRANSFER SCHEME

Courtesy Matt Rodell, NASA-GSFC

NASA Ground Water Product

Source: Satellite

The Gravity Recovery and Climate Experiment (GRACE)



GRACE measures monthly gravity field estimates

Which is affected by the amount of column of terrestrial water

Source: Satellite and Surface Data Assimilated Models

Global Land Data Assimilation System (GLDAS)

GLDAS provides surface and layer soil moisture, snow/ice, surface water

GRACE and GLDAS products together can provide ground water estimates

Gravity Recovery and Climate Experiment

Courtesy: Matt Rodell, NASA-GSFC

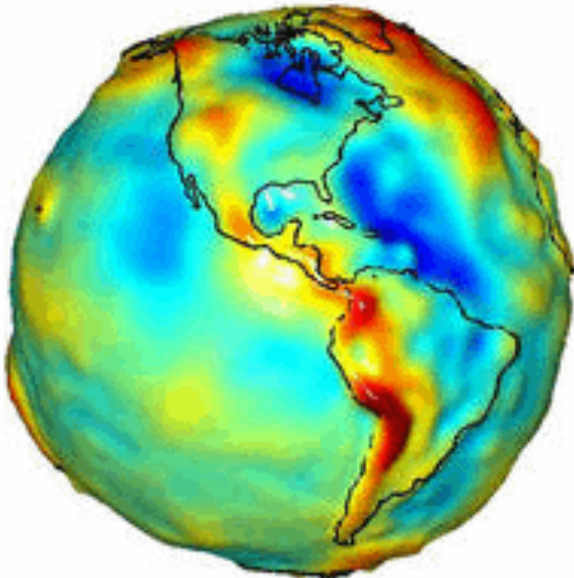


Science Goal: High resolution, mean and time variable gravity field mapping for Earth System Science applications

Instruments: Two identical satellites flying in tandem orbit, 215 km apart, ~485 km altitude

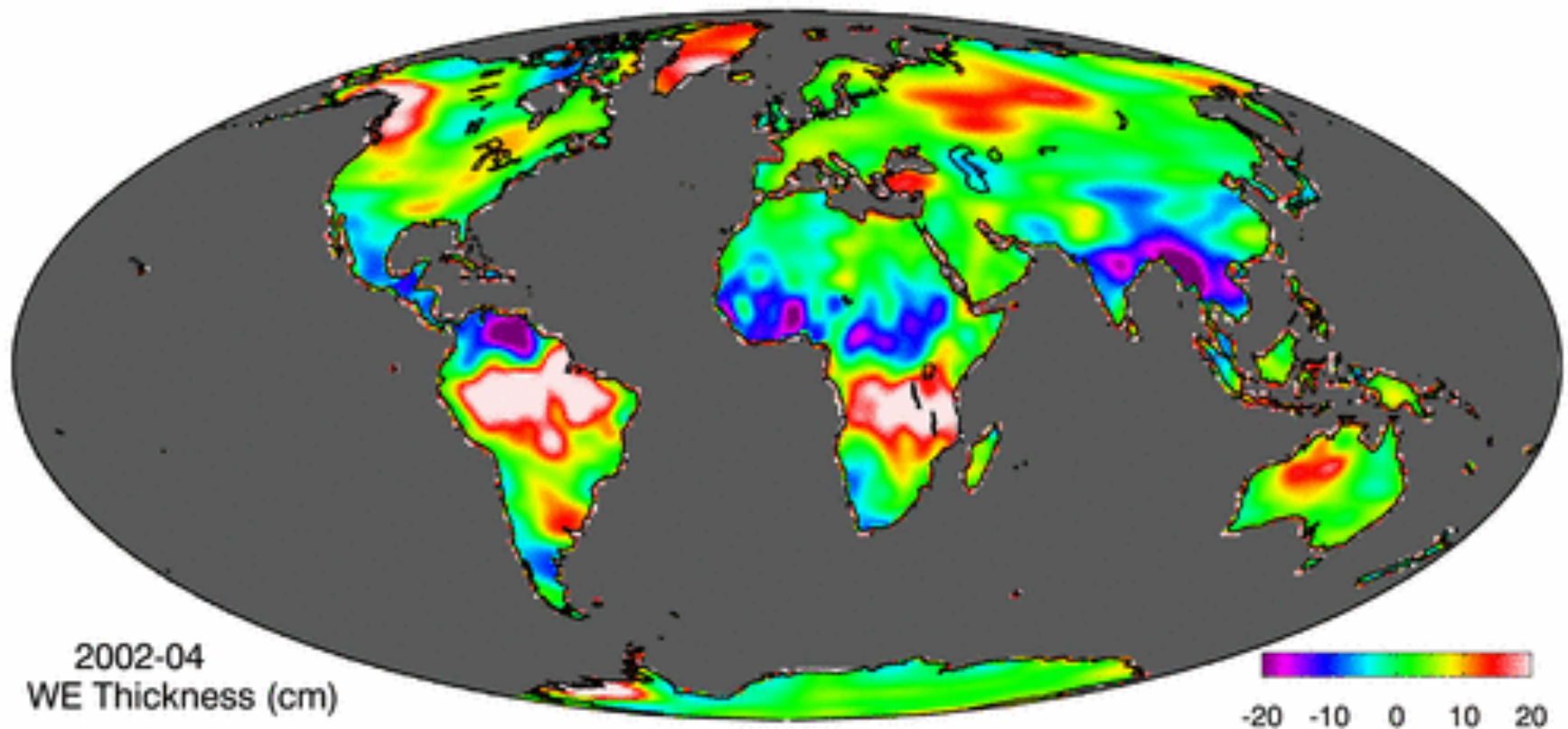
Key Measurements: Location and distance between two satellites tracked by GPS and high precision microwave ranging system

Key Result: Monthly variations in total terrestrial water storage (the sum of groundwater, soil moisture, snow, ice, and surface waters)



Terrestrial Water Storage Variations from GRACE

- Spatial resolution: 150,000 km² or coarser
- Monthly anomalies (deviations from the mean)
- Total column water: groundwater, soil moisture, snow, etc.
- <http://gracetellus.jpl.nasa.gov/data/mass/>



Courtesy: Matt Rodell, NASA-GSFC

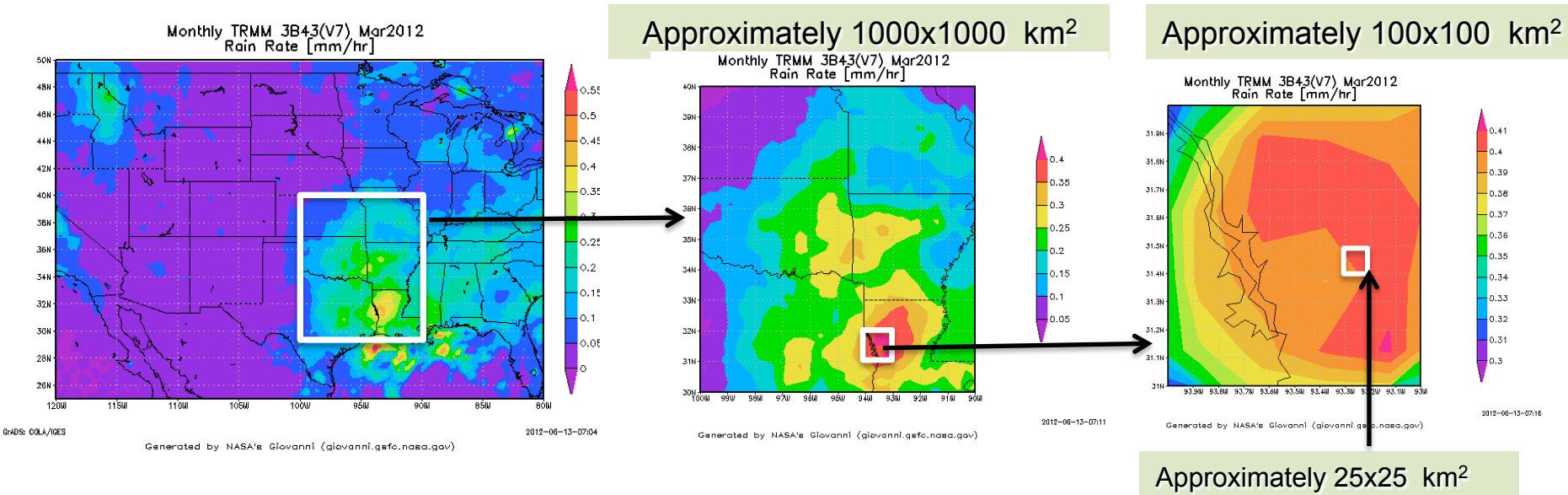
Rain Product Summary

Source/ product	Spatial Coverage	Spatial Resolution	Temporal Coverage	Temporal Resolution
GPCP: Rain Rate	Global	2.5°x2.5° 2.5°x2.5° 1°x1°	1979- present	Daily, 5-day, Monthly
TRMM and multi- satellite merged: Rain Rate Accumulate d Rain	48°S-48° N	0.25°x0.25°	12/1997 to present	3-hourly, Daily, Monthly
MERRA: Rain Rate	Global	1.25°x1.25° 2/3°x1/2°	1979- present	Hourly, Monthly

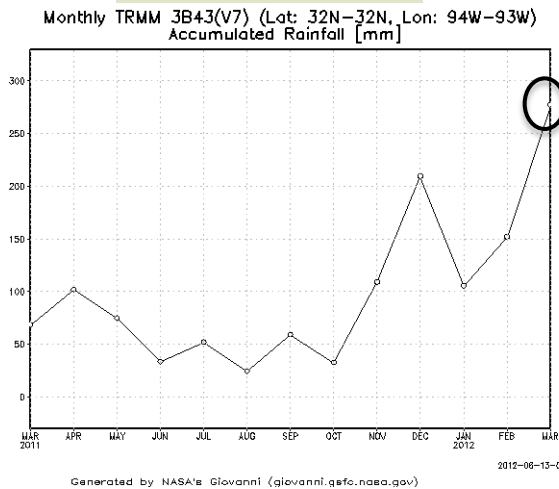
Snow, Soil Moisture, ET Products Summary

Source/product	Spatial Coverage	Spatial Resolution	Temporal Coverage	Temporal Resolution
Terra/Aqua – MODIS: Fractional snow cover and sea ice cover ET Aqua/AMSR-E Snow water equivalent Soil moisture	Global Global	500m, 0.05° (snow) 1 Km and 4 Km (sea ice) 1 Km 0.25°x0.25°	2-2000 to present/ 9-2002 to present 09-2002 to 2011	5 minutes (swath), daily, 8-days, monthly Daily, 8-day, Annual Monthly Twice Daily, Daily, 5-day
MERRA: Fractional snow cover, snow mass, snow depth, snow melt multi-layer soil moisture, ET	Global	2/3°x1/2°	1979-present	Monthly
GLDAS: Snow melt, snowfall rate, snow water equivalent, multi-layer soil moisture, ET	Global	1°x1°	1979-present and 1948- present (phase 2)	3-Hourly, Monthly
NLDAS: Snow melt, snowfall rate, snow water equivalent, multi-layer soil moisture, ET	North America	0.125°x0.125°	1979-present	Hourly

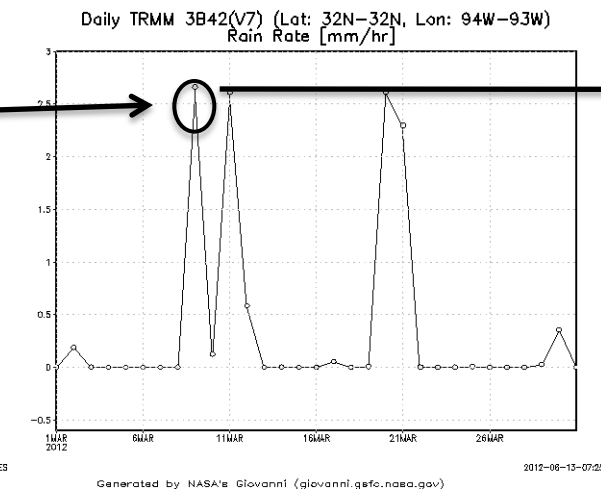
Spatial and Temporal Resolutions



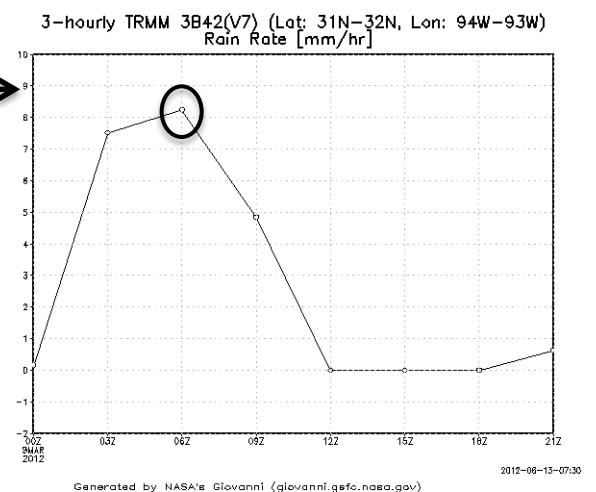
Monthly



Daily



3-hourly



Satellite Products

- There are multiple sources of the same products, with varying spatial/temporal resolutions and accuracies
- There are many assumptions and approximations in going from raw data to specific parameters such as rain amount, snow cover
- Product quality can range from excellent to poor depending on:
 - Instrument capabilities
 - Instrument calibration and performance
 - The algorithms used to interpret the data
 - Physical limitations

Model Products

There are multiple models, with varying spatial/temporal resolutions and accuracies

Modeling of hydrological processes is complex due to presence of water in gaseous, liquid, and solid forms in the earth-atmosphere system

Models use many approximations and assumptions in representing physical processes

Rigorous validation with observations and model-to-model inter comparisons are conducted to assess accuracy of model products

Web-tools, Data Access, Visualization

Giovanni (GES-DISC (Goddard Earth Sciences Data and Information Services Center) Interactive Online Visualization ANd aNalysis Infrastructure) <http://disc.sci.gsfc.nasa.gov/giovanni/>

A Web-based portal that provides visualization, analyze, and access of **GPCP**, **TRMM**, **MERRA**, **GLDAS**, **NLDAS** data without having to download the data

Rain
Snow
Soil
moisture
ET

The screenshot shows the Giovanni web portal interface. The browser address bar displays <http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html>. The page features a navigation bar with tabs for various data categories: ATMOS COMPOSITION, HYDROLOGY, A-TRAIN, AIRS, MODELING, MAIRS, MEASURES, and PRECIPITATION. A sidebar on the left contains a 'Giovanni' section with an 'OVERVIEW' link, and an 'Additional Features' section with links for News, Users Manual, Publications, Newsletters, Feedback, and FAQ. The main content area is titled 'Giovanni - The Bridge Between Data and Science' and includes a 'Giovanni Portals' section with a list of portals. A tooltip is visible over the 'Northern Eurasia Earth Science Partnership Initiative (NEESPI) Monthly Data Products' link. The right sidebar contains a 'GIOVANNI NEWS' section with a list of recent news items. The footer of the page provides the URL http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=neespi_daily.

Giovanni — GES DISC: Goddard Earth Sciences, Data & Information Services Center

<http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html>

Most Visited — Getting Started — 12th Plinius Confere... — Latest Headlines — Yahoo! — Utton Center

Giovanni — GES DISC: Goddard Ea... — Data and Information Services Center

+ ATMOS COMPOSITION + HYDROLOGY + A-TRAIN + AIRS + MODELING + MAIRS + MEASURES + PRECIPITATION

Giovanni

You are here: [GES DISC Home](#) > [Giovanni](#) > [Overview](#) > Giovanni

Giovanni

» **OVERVIEW**

- + What is Giovanni?
- + Who Uses Giovanni?
- + Giovanni Parameters
- + Giovanni Plot Types
- + How to Use Giovanni
- + How to Acknowledge Giovanni
- + Acknowledgements

Additional Features

- + News
- + Users Manual
- + Publications
- + Newsletters
- + Feedback
- + FAQ

Giovanni Portals **Giovanni Parameter List**

Atmospheric Portals

Application and Education Portals

- Northern Eurasia Earth Science Partnership Initiative (NEESPI) Monthly Data Products
- Air Quality
- Agriculture
- Monsoon A
- Monsoon A
- Northern Eurasia Earth Science Partnership Initiative (NEESPI) Daily
- Northern Eurasia Earth Science Partnership Initiative (NEESPI) Monthly
- Coming Soon: Data-enhanced Investigations for Climate Change Education (DICCE) portals

Meteorological Portals

Ocean Portals

Hydrology Portals

GIOVANNI NEWS

Hide News

- Fall 2011 issue of The Giovanni News newsletter is online Nov 18, 2011
- GES DISC releases new home page for Giovanni Nov 18, 2011
- TRMM Version 7 data are now available Nov 03, 2011
- GES DISC scientist participates in remote sensing data workshop Oct 18, 2011
- The difference 8 days makes: new ocean color radiometry data increase information in space and time Oct 11, 2011
- NLDAS Views of 2011 Tropical Storm Lee Sep 29, 2011
- On-the-fly (OTF) Subset Service Available for NLDAS products Sep 29, 2011
- Steamy heat on the plains, July 2011 Sep 23, 2011

[More...](#)

Giovanni is a Web-based application developed by the GES DISC that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data.

Giovanni is comprised of a number of interfaces, called portals, each tailored to meet the needs of different Earth science research communities. To access a Giovanni portal, just click the appropriate link in the lists under the left tab above.

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=neespi_daily

NSIDC (National Snow and Ice Data Center)

<http://www.nsidc.org/>

A portal that distributes data products of snow, ice, glaciers, frozen ground, soil moisture

A tool to display MODIS snow/ice on Google Earth

MODIS
Snow/ice

AMSR-E
snow water
equivalent

AMSR-E Soil
moisture




MODIS ET Product: MOD16

<http://www.ntsg.umt.edu/project/mod16>

The University of Montana

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 **Numerical Terradynamic Simulation Group**
Modeling and Monitoring Ecosystem Function at Multiple Scales

Projects **Data** Publications People Teaching Media Event Contact

MODIS Global Evapotranspiration Project (MOD16)

MODIS

Project Description Documentation Scientists Publications **Data Product**

MOD16 Global Terrestrial Evapotranspiration Data Set

http://modis.gsfc.nasa.gov/data/dataproduct/dataproducts.php?MOD_NUMBER=16

NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION + NASA Homepage

SEARCH GO

MODIS Web

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+ Home

DATA PRODUCTS

Choose A Product

MOD 16 - Evapotranspiration

Description:
This is a land surface evapotranspiration product which represents all transpiration by vegetation and evaporation from canopy and soil surfaces, expressed in 1-dimensional vertical mm/day units. ET is computed globally every day at 1km, using MODIS landcover, and FPAR/LAI data and global surface meteorology from the GMAO. ET is used for water balance calculations for hydrologic management, as a carbon cycle constraint, and for drought and fire danger mapping.

Data

- DATA PRODUCTS

+ ALGORITHMS

DATA PRODUCTS

Choose A Product

- MOD 01 - Level-1A Radiance Counts
- MOD 02 - Level-1B Calibrated Geolocation Data Set
- MOD 03 - Geolocation Data Set
- MOD 04 - Aerosol Product
- MOD 05 - Total Precipitable Water
- MOD 06 - Cloud Product
- MOD 07 - Atmospheric Profiles
- MOD 08 - Gridded Atmospheric Product
- MOD 09 - Surface Reflectance; Atmospheric Correction Algorithm Products
- MOD 10 - Snow Cover
- MOD 11 - Land Surface Temperature and Emissivity
- MOD 12 - Land Cover/Land Cover Change
- MOD 13 - Gridded Vegetation Indices (NDVI & EVI)
- MOD 14 - Thermal Anomalies - Fires and Biomass Burning
- MOD 15 - Leaf Area Index (LAI) and Fractional Photosynthetically Active Radiation (FPAR)
- MOD 16 - Evapotranspiration**
- MOD 17 - Vegetation Production; Net Primary Productivity (NPP)
- MOD 18 - Normalized Water-leaving Radiance
- MOD 19 - Pigment Concentration

Summary

- Multiple sources of NASA water products with different space-time coverage and resolutions
- Each product has its own strengths and limitations
- Product validation and accuracy are available from NASA researchers
- Appropriate products can be selected depending upon end-users' applications

NASA Applied Remote Sensing Training for Water Resource Management

<http://water.gsfc.nasa.gov>

- Find out about upcoming workshops on use of NASA Earth Science data sets and tools
- Access to training materials
- Links to other satellite resources

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Thank You!